Gibson Paradox: Panel Data Analysis on ASEAN-T Countries

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ABSTRACT

The existence of a long-term positive relationship between the nominal interest rate and the general price level is called the Gibson paradox in the economics literature. The main purpose of this study is to test whether Gibson paradox is valid for ASEAN-T countries with quarterly data from 1993:Q1 to 2019:Q4 using panel data analysis. In this context, short- and long-term interest rates and consumer price index variables were used. We first examined our data to investigate whether there was a cross-section dependency in our data set. Because of the cross-section dependency in the series, the CADF unit root test, one of the second-generation panel unit root tests, was used. Panel ARDL (Autoregressive Distributed Lag) bounds test was carried out due to the different stationarity levels of the series. According to the panel ARDL bounds test findings, there is a positive relationship between the long-term interest rate and the consumer price index in both the short and long terms. Therefore, the Gibson paradox is valid in ASEAN-T countries in the period under study.

Key words: *Gibson Paradox, Panel Data Analysis, Panel ARDL Bound Test*

JEL Codes: E00, E31, E40

1. INTRODUCTION

Inflation and interest rate are among the most important macroeconomic indicators in determining economic stability. In this respect, these two indicators, especially the interest rate, have always attracted attention and been the subject of discussion in the field of economics.

Classical economic theory considers money as a cover that does not affect economic events. An increase in the money supply increases the level of inflation at the same rate (Savaş, 2008: 190). The interest rate is determined as a function of real variables such as investment, savings and consumption (Snowdon and Vane, 2005: 42). In this respect, according to classical economic theory, the interest rate is independent of inflation (Özdemir and Yıldırım, 2018: 27).

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The British economist Alfred Herbert Gibson, as a result of the analysis he carried out with Britain data in 1923, revealed that there is a positive relationship between inflation and the long-term interest rate (Gibson, 1923). This view is contrary to the classical macroeconomic theory expressed above. Gibson analysis was expressed as a paradox by commenting that it was "one of the most complete truths in the entire field of quantitative economics" by John Maynard Keynes in 1930. The Gibson paradox (Wicksell, 1907; Fisher, 1930; Keynes, 1930; Sargent, 1973; Shiller and Siegel, 1977; Barsky and Summers, 1988) has been the subject of many studies with empirical methods and possibly theoretical explanations (Keho, 2015: 13).

Evidence for the validity of Gibson's paradox is mixed as a result of empirical analysis. For example, Kitchin (1923) for UK and USA, Barsky and Summers (1988) for UK, Muscatelli and Spinelli (1996) for Italy, UK and USA, Coulombe (1998) for UK and Canada, Yamak and Tanrıöver (2007) for Türkiye and Ogbonna (2014) for Nigeria. Dehghani et al. (2015) obtained evidence supporting the validity of the Gibson paradox for Iran and Bakkal (2021) for Türkiye. However, Benjamin and Kochin (1984), Corbae and Quliaris (1989), Serletis and Zestos (1999), Atkins and Serletis (2003), Halicioglu (2004) found no support for the paradox for the cases of Canada, the USA, Italy, Norway, Sweden, England, and Türkiye.

In this study, the question of whether there is a long-term positive relationship between the nominal interest rate and the general price level, which is referred to as the Gibson paradox in the literature, was investigated for ASEAN countries and Türkiye. As it can be seen from the literature review, it has been determined that the Gibson paradox has not been tested on ASEAN countries until now. Based on the literature gap here, the need to test the validity of the Gibson paradox in ASEAN countries has arisen by including Türkiye in the analysis. According to the results of the research, there is a positive relationship between the long-term interest rate and the consumer price index. Accordingly, the Gibson paradox is valid in the ASEAN-T countries in the analyzed period.

After the theoretical framework was briefly summarized in the study, a detailed literature summary was added. After introducing the methodology and data set used in the next section, the study was concluded with conclusion and policy recommendation.

2. LITERATURE REVIEW

Table 2.1 summarizes the studies that empirically examined the Gibson paradox worldwide. Within the framework of the studies examined, it has been empirically revealed that the Gibson paradox is valid in some studies, but it has been concluded that the paradox is not valid in some studies.

Author/s	Country/s	Period	Variables	Method	Results
Gibson (1923)	United Kingdom	1773-1923	Inflation and bond yield	Simple correlation	Gibson's Paradox applies.
Kitchin (1923)	United Kingdom and United States	1773-1923	General level of prices and interest rate	Simple correlation	Gibson's Paradox applies.
Friedman and Schwartz (1982)	United Kingdom and United States	1870-1975	General level of prices and nominal interest rate	Regression analysis	Gibson's Paradox applies.
Benjamin and Kochin (1984)	United Kingdom	1729-1931	Bond yield, index of wholesale prices and defence expenditures	Regression analysis	Gibson's paradox does not apply.
Barsky and Summers (1988)	United Kingdom	1730-1938	General level of prices and bond yield	Regression analysis	Gibson's Paradox applies.
Corbae and Quliaris (1989)	United States and United Kingdom	1920-1986 1890-1982	Nominal interest rate and general level of prices	Regression analysis	Gibson's paradox does not apply.
Klein (1995)	United States	1930-1994	General level of prices and interest rate	Vector error correction model	Gibson's Paradox applies.
Muscatelli and Spinelli (1996)	Italy, United Kingdom and, United States	1815-1995	General level of prices and long-term interest rate	Regression analysis	Gibson's Paradox applies in the United Kingdom and United States, not Italy.
Cochran (1997)	United Kingdom and United States	1730-1981, 1800-1981	General level of prices and interest rate	VAR analysis	Gibson's paradox does not apply.
Coulombe (1998)	United Kingdom and, Canada	1717-1914, 1954-1994	General level of prices and bond yield	ARMA, ADF and PP unit root test	Gibson's Paradox applies.
Serletis and Zestos (1999)	Denmark, Belgium, Germany, France, United Kingdom, Ireland,	1957:1-1994:4	Nominal interest rate and general level of prices	Correlation and unit root test	Gibson's paradox does not apply.

	Netherlands and Italy				
Dowd and Harrison (2000)	United Kingdom	1821-1913	General level of prices and interest rate	Cointegration analysis	Gibson's Paradox applies.
Atkins and Serletis (2003)	Canada, United States, Italy, Norway, Sweden and United Kingdom	1880-1986	Nominal interest rate and inflation	ARDL bound test	Gibson's paradox does not apply.
Halicioglu (2004)	Türkiye	1950-2002	General level of prices and interest rate	Cointegration analysis	Gibson's paradox does not apply.
Hannsgen (2004)	United States	1954-2004	General level of prices and bond yield	Causality analysis	Gibson's Paradox applies.
Yamak and Tanrıöver (2007)	Türkiye	1990-2006	General level of prices and interest rate	ARDL bound test	Gibson's Paradox applies.
Mills (2008)	United Kingdom	1750-1914	General level of prices and interest rate	Regression analysis	Gibson's Paradox applies.
Şimşek and Kadılar (2008)	Türkiye	1987-2004	Consumer price index and nominal interest rate	Granger causality analysis and error correction model	Gibson's Paradox applies.
Yapraklı and Yurttançıkmaz (2010)	Türkiye	1970-2009	General level of prices and interest rate	Johansen cointegration and error correction model	Gibson's Paradox applies.
Cheng et al., (2013)	China	1873-1924	Index of wholesale prices and interest rate	Ordinary least squares (OLS) method	Gibson's Paradox applies.
Aklan et al., (2014)	Türkiye	1982-2013	General level of prices and interest rate	Johansen cointegration analysis	Gibson's Paradox applies.
Chadha and Perlman (2014)	United States, Italy, Sweden, United Kingdom, France and, Germany	1798-1913	General level of prices and interest rate	VAR analysis	Gibson's Paradox applies.

Ogbonna (2014)	Nigeria	1970-2012	General level of prices and interest rate	Fourier ADL cointegration and Granger causality analysis	Gibson's Paradox applies.
Dehghani et al., (2015)	Iran	1978-2013	General level of prices and interest rate	ARDL bound test	Gibson's Paradox applies.
Koçyiğit et al., (2015)	Türkiye	2003-2015	Consumer price index and interest rate	Toda Yamamoto analysis	Gibson's Paradox applies.
Altunöz (2017)	Türkiye	1988-2015	Quarterly interest rate and consumer price index	ARDL bound test	Gibson's Paradox applies.
Yıldırım (2017)	Türkiye	2002-2015	Consumer price index and interest on domestic borrowing	Johansen cointegration and Engle Granger causality analysis	Gibson's Paradox applies.
Kofoğlu (2018)	Türkiye	1965-2017	Nominal interest rate and inflation	Engle-Granger, Johansen-Juselius cointegration, VAR analysis and ARDL bound test	Gibson's Paradox applies.
Özdemir and Yıldırım (2018)	Türkiye	2002:1-2017:4	Consumer price index, bond yield and deposit interest rate	Johansen cointegration analysis	Gibson's Paradox applies.
Altunöz (2020)	Türkiye	1995-2019	Interest rate and inflation	ARDL bound test and structural causality analysis	Gibson's Paradox applies.
Kofoğlu (2020)	Türkiye	1965-2017	Interest rate and inflation	ARDL bound test	Gibson's Paradox applies.
Atgür (2021)	Türkiye	2004-2020	Nominal deposit interest rate and consumer price index	Granger causality analysis, error correction model and Johansen	Gibson's Paradox applies.

				cointegration analysis	
Bakkal (2021)	Türkiye	1982-2020	Bank deposit interest rate and inflation rate	Engle Granger and Maki with multiple structural fractures cointegration analysis	Gibson's Paradox applies.

Table 2.1 Previous Work on the Gibson Paradox.

3. RESEARCH METHODOLOGY

In this section, the model and methodology of the study will be explained and empirical findings will be presented.

3.1. Model

Consumer price index, short- and long-term interest rate specifications were provided by Kamiar Mohaddes (University of Cambridge) and Mehdi Raissi (IMF) from the updated 2019 GVAR dataset (2020), which revised the previous 2016 version. In the study, Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Thailand, Philippines, Vietnam and Singapore, which are the founding countries of the Southeast Asian Nations Association (ASEAN), including Türkiye, were examined with a model. On the other hand, Stata 17 and Eviews 12 package programs were used for the analysis.

In this study, where the validity of Gibson's Paradox was investigated for the member countries of ASEAN and Türkiye, the logarithmic model is shown in Equation (3.1):

$$lnI = \beta_0 + \beta_1 \, lnIR + \beta_2 \, lnLIR + \varepsilon_t \qquad (3.1)$$

In equation (1), the notation *I* represents the rate of inflation in terms of consumer price index, *IR* represents the short-term interest rate, *LIR* represents the long-term interest rate, and ε_t represents the error term.

3.2. Method

In this section, the econometric methods used in the study will be discussed.

3.2.1. Cross-Sectional Dependence Test

In the studies where panel data analysis is performed, the fact that the horizontal sectional units constituting the panel are independent of each other is very important for the results of the analysis. Cross-sectional independence is based on the assumption that all countries are affected by a shock to any of the units in the panel and that the other countries constituting the panel are not affected by a macroeconomic shock that occurs in any of the countries. With the increase in the level of international trade and the degree of financial integration in our world today, and thus the acceleration of globalization, it is more realistic that an economic shock in any country will affect

other countries differently, just as in the global financial crisis that occurred in 2008. For this reason, since the results of the analysis performed without taking into account the cross-sectional dependence may be deviant and inconsistent, it is necessary to test whether there is a dependence between the horizontal sections as a priority in the analysis (Mercan, 2014: 235; Menyah et al., 2014: 389; Koçbulut and Barış, 2016: 28-29).

In the study, the CD_{LM1} test developed by Breusch and Pagan (1980) the CD_{LM2} test developed by Pesaran (2004), and the Bias-Adjusted CD tests developed by Pesaran et al., (2008) were used to measure whether cross-sectional dependence was involved in the series, and the null and alternative hypotheses of these tests are as follows:

H_0: There is no cross-sectional dependence.
H_1: There is a cross-sectional dependence.

The regressions used to test the null hypotheses in the LM test developed by Breusch and Pagan (1980) and the CD_{LM} tests of Pesaran (2004) are included in Equation (3.2) and Equation (3.3), respectively:

$$LM=T \sum_{i=1}^{N-1}\sum_{j=i+1}^{N} P_{ij}^2, \qquad X^2 \sim (N\text{-}1)/2 \tag{3.2}$$

$$CD = \sqrt{2T/N(N-1)}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N} P_{ij}\right) \tag{3.3}$$

The *T* notation in equations (3.2) and (3.3) can be used in *T*>*N* and *N*>*T* states to show the time dimension and the number of N sections in the panel and give consistent results. If the *p* value is less than 5 percent in the test results to be obtained from these tests, the H_0 hypothesis is rejected at the 5% significance level. In other words, it is concluded that there is a cross-sectional dependence between units (Pesaran, 2008: 17).

3.2.2. Slope Homogeneity Test

In this study, the homogeneity of the slope coefficients of the model is examined with the slope homogeneity test developed by Pesaran and Yamagata (2008).

$$\Delta = \sqrt{N}\left(\frac{N^{-1}\hat{S}-k}{\sqrt{2k\,(T-k-1)\,/T+1}}\right) \quad \sim N\,(0,\,1) \tag{3.4}$$

Small and large samples in homogeneity test there are two test statistics for the slope. In both of these test statistics, the slope H_0 hypothesis that the coefficient is homogeneous is tested.

3.2.3. CADF Panel Unit Root Test

The stationarity of the series was tested by the CADF panel unit root test, which is a second-generation unit root test developed by Pesaran (2007) that takes into account cross-sectional dependence. In the CADF test, lagged cross-sectional averages obtained from Augmented Dickey-Fuller regression are taken into account. The CADF regression is shown in equation (3.5):

$$Y_{i,t} = (1 - \phi_i)\, u_i + \phi_i y_{i,t-1} + u_{it} \; i=1,\ldots,N;\; t=1,\ldots,T \tag{3.5}$$

It expresses the u_{it} error term in equation (3.5) and as in equation (3.6) is calculated.

$$u_{i,t} = y_i\, \int_t + £_{it} \tag{3.6}$$

In equation (3.6) $\int_t$ represents the unobservable common element and is always assumed to be stationary. $£_{it}$ is a series-specific element and is independently and identically dispersed.

By transforming (3.5) and (3.6), the equations can be represented as in (3.7):

$$\Delta y_{it} = a_i + \beta_i y_{i,t-1} + \gamma_i \int_t + £_{it} \tag{3.7}$$

In equation (3.7) $a_i=(1 - \phi_i)\, u_i$, β= -$(1 - \phi_i)$ $\Delta y_{it}= \gamma_{it}$-$y_{it-1}$ mean (Küçükaksoy and Akalın, 2017: 28).
After the CADF regression is estimated, the CIPS statistics are calculated from the mean ($CADF_i$) of the t statistics of the delayed variables. CIPS statistics (Pesaran, 2007):

$$CIPS = CADF_i = \frac{\sum N_{i=1} CADF_i}{N} \tag{3.8}$$

The H_0 hypothesis of the CADF test is "there is a unit root" and the H_1 hypothesis is “there is no unit root". If p-value of test statistics is less than 5 percent, the null hypothesis is rejected and the series is decided to be stationary (Pesaran, 2007: 268).

3.2.4. Panel ARDL Analysis

In the ARDL method, unlike other cointegration tests, there is no need to know whether the variables are stationary or not. On the other hand, Panel ARDL models do not only include the lagged values of the dependent variable. In addition, the current and lagged values of the independent variables are also included (Pesaran et al., 2001). The estimators of the panel ARDL method are the Mean Group (MG) and Pooled Mean Group (PMG) estimators. The modified version of MG developed by Pesaran et al. (1999) allows PMG error variance and short-term coefficients to vary between groups and assumes that the long-term coefficients are the same, while the MG estimator allows all slope coefficients and error variances to vary across countries.
Pesaran et al., (1999) proposed that the homogeneity test of long-term parameters should be performed by the Hausman (1978) test. The determination of the lag length) in the series can be made according to the Akaike or Schwarz information criteria.

3.3. Empirical Findings

In the study, before moving on to the empirical findings, the descriptive statistics of the variables in the analysis are given in Table 3.1.

	I	IR	LIR
Mean	0,019	0,023	0,009
Median	0,008	0,010	0,008
Maximum	0,343	0,206	0,021
Minimum	-0,035	0,000	0,001
Standard Deviation	0,035	0,033	0,004
Skewness	3,770	2,663	0,366
Kurtosis	20,829	9,882	2,402
Jarque-Bera	10118,48	2044,838	24,185
Probability Value	0,000	0,000	0,000
Observations	648	648	648

Table 3.1 Descriptive Statistics of Variables

As it can be seen in table 3.1 the average of all three variables is positive. The standard deviation values are close to each other in the consumer price index and short-term interest rate variables. Because the probability value of the series is less than the critical value of 5%, it means that, the series is not normally distributed.

Test	Variables					
	I		IR		LIR	
	Statistics Value	Probability Value	Statistics Value	Probability Value	Statistics Value	Probability Value
Breusch-Pagan LM	152,391	0,000	801,895	0,000	1608,852	0,000
Pesaran scaled LM	25,084	0,000	143,666	0,000	290,996	0,000
Bias-corrected scaled LM	25,056	0,000	143,638	0,000	290,968	0,000
Pesaran CD	9,980	0,000	28,095	0,000	40,110	0,000

Table 3.2 Cross-Sectional Dependence Findings.

Notes: The Breusch-Pagan (1980) Lagrange Multiplier Test, Pesaran (2004) scaled Lagrange Multiplier Test, Baltagi, Feng and Kao (2012) deviation-corrected scaled Lagrange Multiplier Test and Pesaran (2004) cross- sectional dependence test were applied respectively to test for cross-sectional dependency, and the null hypothesis for each test statistic is that there is no cross-sectional dependence.

As can be seen in table 3.2, the probability value of all three variables in all four tests is less than 5 percent. Therefore, according to all four tests, the series contains cross-sectional dependence.

	Model	
Tests	Statistic Value	Probability Value
Delta Tilde	22,266*	0,000
Delta Tildeadj	22,691*	0,000

"*"1% indicates significance level.

Table 3.3 Slope Homogeneity Test Findings

Hypothesis H_0, which is based on the assumption of homogeneity of the model, is rejected at the 1% significance level and it is concluded that the model is heterogeneous. This finding reveals that the impact of a change in the short-term interest rate and the long-term interest rate on the consumer price index is different across countries.

Countries	Variables	Level		First Difference	
		Lags	T Statistic	Lags	T Statistic
Brazil	I	0	-5,366*	1	-7,589
	IR	0	-3,157***	1	-7,601
	LIR	0	-1,392	0	-9,772*
Russia	I	0	-3,748**	4	-5,737
	IR	4	-1,963	3	-8,013*
	LIR	0	-2,049	1	-6,703*
India	I	1	-4,651*	2	-6,881
	IR	4	-2,664	4	-6,055*
	LIR	0	-2,405	4	-7,683*
China	I	4	-1,116	3	-3,337**
	IR	0	-3,050***	4	-8,890
	LIR	0	-1,043	1	-7,103*
South Africa	I	2	-5,686*	0	-9,801
	IR	0	-3,302**	4	-5,110*
	LIR	0	-1,233	0	-9,202*
Türkiye	I	0	-4,589*	0	-9,592
	IR	0	-2,359	3	-6,518*
	LIR	0	-1,496	1	-7,410*
Panel CIPS	I		-4,193*		-6.335
	IR		-2,749*		-6,991*
	LIR		-1,603		-7,979*

Table 3.4 CADF Unit Root Test Findings

Notes: The notations *, **, *** represent 1%, 5%, and 10% significance respectively. Since the data are quarterly, the maximum lag length is chosen as 4 according to the Schwarz information criterion and model with constant. Critical values are taken from Pesaran (2007). Critical values for panel CADF are 1%:-3,88, 5%:-3,24 and 10%:-2,92. Critical values for panel CIPS are 1%: -2,53, 5%:-2,32 and 10%:-2,21.

As can be seen in Table 3.2, in the Panel CIPS test, the calculated test statistics of the consumer price index (I) and short-term interest (IR) rate variables are greater than the critical values in absolute value, therefore the series are level stationary. When analyzed by countries, only China has a unit root at the consumer price index level. The short-term interest rate variables of Russia, India and Türkiye contain unit root at the level. The long term interest rate variable contains unit root at both panel and country level. However, it becomes stationary when it takes the first difference.

Estimator	Chi-Sq Statistic	Probability Value
MG, PMG	8,892	0,011

Table 3.5 Hausman Test Findings

When table 3.5 is examined, the Chi-Square value of 8,892 and the probability value of 0,011 show that the variables are heterogeneous at a significance level of 5% in the long term. According to this result, the H_0 hypothesis is rejected. Therefore, it can be said that, the MG forecaster is more effective and consistent between MG (Mean Group) and PMG (Pooled Mean Group). Accordingly, the most appropriate forecaster within the scope of the model is the MG forecaster.

Dependent Variable (I)	Short Term			Long Term		
Variables	Coefficient	Standard Error	Probability Value	Coefficient	Standard Error	Probability Value
IR	0,2781**	(0,138)	0,045	0,4256	(0,2798)	0,128
LIR	3,3461**	(1,549)	0,031	0,2567***	(0,1480)	0,083
ECM_{t-1} : - 0,738* (0,061)						

Table 3.6 Panel ARDL MG Test Findings
Notes: The notations *, **, and *** represent 1%, 5%, and 10% significance respectively. On the other hand, according to the Schwartz information criterion, the lag length is set at 8. The value in parenthesis indicates the standard error.

According to the MG forecast results in Table 3.6, increases in IR and LIR variables were found to increase the consumer price index in the short term. In the long term, the short-term interest rate is statistically meaningless, while the long-term interest rate is statistically significant at the 10 % significance level and has an effect on increasing the consumer price index.

4. CONCLUSION

In this study, the validity of the Gibson paradox was tested for ASEAN-T countries with quarterly data from 1993:Q1-2019:Q4. In this context, Panel ARDL analysis was carried out. According to the panel ARDL findings, while there is a positive relationship between both the short-term interest rate and the long-term interest rate

and the consumer price index, in the long term there is only a positive relationship between the long-term interest rate and the consumer price index. Therefore, the Gibson paradox is valid in ASEAN-T countries in the period under study.

When the result of the analysis is evaluated, it is necessary to make a change in the interest rate by taking into account price stability, and it is also important that the central banks give the right signal to the market with communication tools and credibility in this process. However, since interest is also a cost element, it should not be ignored that a change in interest rates through the cost channel will be reflected in the supply and demand-side consumer price index, respectively.

On the other hand, the validity of the Gibson Paradox also shows that developing countries that want to attract foreign capital may face a threat. As a matter of fact, when developing countries raise their interest rates, they may encounter inflation problems, as a result of which the current account deficit increases and the countries dependence on foreign capital increases. Therefore, one of the most important priorities for economies should be to reduce the dependency on speculative short-term foreign capital or to encourage the entry of long-term foreign direct capital into the country. It can be said that the increasing dependence on speculative short-term capital (hot money) makes it difficult to get out of the interest-inflation spiral. In future studies, it is thought that in addition to the short and long-term interest rates, including variables such as bond interest, deposit interest, etc. will contribute and add value to the literature.

Findings obtained in the study were reported by Şimşek and Kadılar (2008), Yapraklı and Yurttançıkmaz (2010), Ogbonna (2014), Dehghani et al. (2015), Altunöz (2017), Kofoğlu (2018), Atgür (2021).

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